RESEARCH PROGRAM ON COMMUNICATIONS POLICY
Center for Technology, Policy, and Industrial Development
Massachusetts Institute of Technology

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Federal Communications Commission
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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Advanced Television Systems	)	
and Their Impact Upon the	)	MM Docket No. 87-268
Existing Television Broadcast	)	
Service	)	

FCC 96-207 – FIFTH FURTHER NOTICE OF PROPOSED RULE MAKING

COMMENTS OF

Research Program on Communications Policy
Massachusetts Institute of Technology
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July 10, 1996

MIT RPCP files these comments on July 10, 1996, in the FCC's Fifth Further Notice of Proposed Rule Making in the Matter of Advanced Television Systems, MM Docket No. 87-268.

Submitted by:

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The MIT Research Program on Communications Policy has participated in the high-definition and advanced television process for over a decade. RPCP's work under MIT's Audience Research Laboratory first demonstrated the psycho-kinesthetic phenomenon whereby high-quality sound enhanced viewer's perception of picture quality, indicated that most viewers would prefer high-definition images only on very large screens, and this year, with the Polaroid Corporation, demonstrated the feasibility of building a full production-quality progressive-scanned high-definition camera, with a vertical resolution higher than the proposed 1080 interlaced HDTV format [see Attachment A].

In 1990, RPCP formed an industry-wide collaborative, the Committee on High-Resolution Systems (COHRS). COHRS succeeded in indicating a better direction than adoption of the obsolete 1125/60 analog interlaced HDTV proposal as a world production standard by the U.S. Department of State and the International Telecommunication Union. COHRS' submission [see Attachment B] established the ground rules for all succeeding digital U.S. proposals. Had the ITU recommended the 1125/60 system at that time, the market for digital advanced television would have been either restricted or eliminated just as digital image technology was reaching maturation. We find that this is an important parallel for the FCC to contemplate in setting parameters or standards for future television systems in the U.S.

MIT RPCP's goal is to bring a fair balance in policy analysis based on accurate technological assessments and an understanding of the economic and political considerations for the best public good. A decision by the FCC on choosing an advanced television set of standards is widely recognized to have impacts far beyond that of just television broadcasting – a point which RPCP was among the first to raise before the ATV process began. As television, and motion pictures in general, have had an immense influence on the culture, politics, and economics of the 20th Century, it is to be expected that any order of magnitude advance in imaging (and sound) which would come closer to bringing distant realities into the home, office, and school more cost-effectively and more easily will have significant influences on the course of the 21st Century.

One of the essential facts of electronic technology for the past century has been constant and rapid change. Ever since the FCC issued its first notice on Advanced Television 9 years ago, it has been clear to all observers that the pace of technological change is accelerating. We maintain that there is no end in sight of this acceleration. One rule of thumb is that the power of microprocessors doubles every 18 months. Advanced Digital Television has the opportunity to move into this new arena of rapid technological improvement.

Conventional television technologies are indeed very much different from that of the systems first introduced some 60 years ago. Though the past pace of technological change was sluggish by today's measures, television today is an upgraded, electronic analog of the original mechanical scanning disks dating from the 1920s and 1930s. Even as late as 1944, when the FCC adopted the 525-line NTSC modified monochrome standards, a sophisticated analog of the spinning Nipkow disk was the best electronic engineers could do with vacuum tubes. NTSC-color standards, dating from 1953, was a further adaptation of NTSC monochrome, made all the more complex because of a failure to anticipate the early demand and technological feasibility of all-electronic color systems in the deliberations of the National Television Systems Committee during the 1930s.

All of these "enhancements" could not remove the consequences of the original compromises and constraints. NTSC transmission today uses spectrum inefficiently, and has many other defects and impairments, not the least of which is that its raster and scanning methods are incompatible with computer communications technology.

It is worth noting that the FCC had to reverse itself in 1953 in order to adopt electronic color after mandating the CBS mechanical color wheel, using spinning mirrors, as the official U.S. color television system in 1947. Mandating a bygone technology is rarely a good idea during an era of rapid change; it is even worse when the technology is simply not good enough to bring to market, as mechanical scanning was. This is an important lesson for today, since imaging and processing technology is changing very fast. Proposals to mandate ideas which are over half a century old and are rapidly approaching obsolesce may not prove to be in the best interest of the public.

No matter what transmission standards the FCC adopts for advanced television, future video technologies will be based on digital processing techniques and use electronics not even imagined when television was first invented.

Hence, we at MIT RPCP recommend that Advanced TV not continue many of the NTSC compromises originally adopted because of the rudimentary electronic constraints of the day. Advanced electronics and digital signal processing has made the following compromises obsolete and harmful:

1) Interlaced scanning, originally adopted to keep the speed of the spinning scanning disks within safe parameters, and then utilized for electronic television as a crude form of bandwidth compression to conserve transmission spectrum, and to facilitate designs of cathode-ray camera and display tubes. Interlace is one of the reasons television does not have the visual clarity of film. Interlace artifacts compromise resolution; interlace compromises the use of high-efficiency digital signal processing for maximum compression without perceptible loss; and interlace requires

costly and complex signal processing to make text and fine-line computer graphics acceptable though still impaired to the human eye. For this reason alone, all computer monitors use progressive scanning to prevent interlace artifacts from degrading text and graphics. With the development of the MIT-Polaroid progressively scanned, high-resolution camera there is no longer any need to require interlace in the video chain.

2) Non-square image rasters, usually referred to as non-square "pixels." The Grand Alliance proposes transmitting multiple raster shapes for different formats, which would require additional processing inside of the display. This would mean it would be difficult and unnecessarily costly to overlay computer-generated images (square rasters or pixels) on non-square-pixel camera-generated HDTV images, without inducing further annoying artifacts. The non-square raster of NTSC was another compromise to reduce the bandwidth in cameras and displays; this is no longer necessary or desirable with modern equipment. All images should be transmitted as square rasters, with any necessary production conversions taking place at the transmitting end, to be perfectly compatible with future display technologies such as lightvalve projectors and flat screens. Computer screens today use square rasters, and the MIT-Polaroid HDTV proscan camera uses a square raster.

3) Fixed image aspect ratio. Interlaced scanning combined with cathode-ray tubes required fixing the aspect ratio as part of the transmitting standard since the flyback scan (for mechanical scanners, original iconoscope CRT camera tubes, or interlaced CRT displays) had to know where the alternate line started; otherwise the image will display distortions rather quickly. With progressive scan, the aspect ratio can be defined on the fly (in the data header), and the image can be represented without distortion. Hence, films can be shown in the form intended, and different applications can use the most appropriate aspect ratio for capture, transmission and display. The American Society of Cinematographers has most elegantly described this problem by illustrating da Vinci's "The Last Supper" as a 12-, 10-, 8-, or 6-disciple Supper, depending on which of some 13 different aspect ratios are used (including 16:9, which is an 8-disciple picture).

4) Fixed frame rate. Without interlaced fields (half frames) in the transmission chain, there is no need to fix the frame rate since now capture, transmission, and display can be readily decoupled. Higher frame rates can be used to capture sporting events, for example, and lower frame rates (e.g., 24 frames per second) can be used to maintain the "film look" – strictly an artistic decision for the creative community. Display refresh can be multiples of the lower rates to prevent flicker on the screen, though it should be noted that emerging display technologies (e.g., matrix flat screen or lightvalve displays) can avoid flicker so that a display refresh is a somewhat meaningless term. The MIT-Polaroid progressive camera runs at 60 frames per second (double that of current NTSC television and the

proposed 1080I format) with as short as a 1/500 second electronic shutter. It is as sensitive as any other HDTV studio camera and will produce the best pictures of sporting events.

5) Fixed compression. With an all-digital transmission system, and de-coupled capture, storage, transmission, and display (facilitated by progressively scanned images) there is no need for a fixed compression system. The compression algorithm can be specified in the header structure (and even downloaded in the header if necessary) and improved as technology improves. Optimum compression schemes depend very much on how the image is captured, stored and transmitted. If a fixed compression scheme is mandated at this early date for over-the-air transmission, it is likely to be obsolete for other media in a very short time.

Therefore, in order to promote a truly advanced and forward looking digital television system that benefits the United States and its citizens, is applicable across industries and services beyond just television, and to set an example of leadership for the rest of the world, we implore the Commission to choose for the future, not the past, a DTV system that employs progressive, square pixel image formats with specifiable aspect ratio, frame rate, and digital coding. Doing otherwise will prove costly and futile.

Attachment A

Memorandum to: U. S. National Committee for CCIR Study Group 11

From: The Ad Hoc High-Definition Display and Television Working Group

Subject: U.S. position at the March IWP 11/6 in Atlanta on the "single worldwide standard for HDTV programme production and international programme exchange"

Date: 22 February 1990

We would like to thank this study group and other associated organizations for their energy and efforts to orchestrate the adoption of an HDTV standard for international production and program exchange which would allow the United States to move forward into the next generation of technology and communications. Your collective efforts have captured our attention.

Equally important, the recent rapid pace of technological change has convinced us that the destinies of the television and broadcast industry, the cable industry, the motion picture industry, information services industries, local telephone and interexchange carriers, the computer and related high-technology industries, and the national scientific and research community are inextricably intertwined in the convergence of computers, consumer and professional electronics, and transmission media.

These industries are going through vast changes: Within the past few years, image, digital signal, and information processing have improved by several orders of magnitude. Further, one can now buy the equivalent of half a Cray 1S in a desktop workstation at last years' workstation prices. The world telecom carriers are rapidly digitizing, with consequent influence on software and hardware. Such advances in overall technology, fueled by America's seemingly insatiable demand for all new forms of information technology, were simply not known or accepted by many in the imaging field with any degree of confidence even two years ago.

The combination of these two factors -- the perceived urgency for an HDTV production and exchange standard, and the recognition that this standard must be much more than a new generation of consumer television -- has led to our collective desire to contribute to the important discussions of what this new high-definition media standard must be if we are to accommodate all competing and complementary interests in the U.S. fairly, and to maximum competitive advantage.

Indeed, the adoption of this standard represents a tremendous new opportunity for America to regain lost ground in the technology race by taking advantage of our traditional strengths: technological innovation and entrepreneurial creativity. (Importantly, there are several companies represented in our ad hoc body which employ fewer than 100 people, but which are nonetheless respected in their industry for innovative and leading-edge products. Academic and scientific institutions are represented as well.)

Therefore,

We conclude that a productive, extensible, and globally useful definition of advanced television and other high resolution imaging systems will require the full efforts of

competent engineering and manufacturing expertise if it is to be accomplished in the time frame of the next CCIR study cycle.

It is our unanimous consensus that we must cooperate on the creation of a standard that:

1) provides advantages to all the industries involved, and

2) lowers artificial barriers to entry in the competition for future technology, software, and transmission markets, particularly in light of the expected advances in media, distribution, and computation technology.

In short, we feel that it is in the best interests of the United States to continue to work on standards characteristics to achieve a family that will benefit all American industries and institutions. This path is particularly important as we await the outcome of the FCC's Advanced TV Inquiry. NO PRODUCTION STANDARD SHOULD BE ADOPTED UNTIL THAT OUTCOME IS KNOWN.

Therefore, we recommend to the U. S. Department of State, that the US delegation to the March CCIR IWP 11/6 meeting endorse a continuation of the work on an HDTV standard for international production and program exchange during the next 4-year study cycle, in the context of the broader interests of all U.S. industries.

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